Appendix E

Data Collection Report

This report was presented to the project team at an earlier date to summarize the data collection phase of the study. Some of the tables, charts and exhibits presented in this preliminary report are used elsewhere in the final report but are updated with more refined information and calculations.

Data Collection Report Appendix E - 3

Summary of Data Collection Activity

Anaerobic Digesters for King County Dairies

Contract # T01664T

Deliverable Under Step 1 Task 5

King County

Department of
Natural Resources and Parks
Water and Land Resources Division
201 South Jackson Street, Suite 600
Seattle, WA 98104

Environmental Resource Recovery Group, LLC

February 10, 2003

Contents

Enumclaw Plateau Dairymen

This is a summary of information collected in fulfillment of the Step 1- Task 1: Collect Data from the Dairy Producers. A data collection questionnaire was developed, all dairymen were invited to a meeting held at the Newakum Grange Hall, and approximately half of the Plateau's dairymen were visited at their farms. The respondents represent more than 2/3 of the dairy cow population. The summary is of both the questionnaire responses and personal and phone conversations.

Non-Dairyman Information Sources

These are summaries of interviews and phone conversations with the various information sources and parties to the project other than the Enumclaw dairymen. They support Step1- Task 2: Collect data from Non-Dairy Entities, Step 1-Task 3: Utility Information and Step 1-Task 4: Other Data Collection.

Individuals cited include: Elissa Benson, Rick Reinlasoder, Josh Marx and Kevin Owens of King County; Doug Faulkner of Puget Sound Energy; Doug Howell and Marilynn Semro of Seattle City Light; Geoff Reed and Clare Flanagan of King Conservation District; Jim Kerstetter of WSU; Angus Duncan of Bonneville Environmental Foundation; Ross Lahren of NRCS and several others who provided price, cost and marketing data.

Puget Sound Energy

Seattle City Light

Bonneville Environmental Foundation

King County Solid Waste

King Conservation District

Exhibits

Exhibit 1 -- Map Showing Prime Location for Central Digester

1. Red lines are power lines easily capable of handling 1 MW power generation load.
2. Yellow area is prime location area from the standpoint of inbound transportation.
3. Site 1 is an excavating company yard and is probably available to purchase. Another available site is directly across the road to the north.
4. Blue dots are "likely participant" dairies

Includes elements from Step 1-Tasks 1, 2, 3 and 4.

Exhibit 2 – Dairies of Enumclaw Plateau and Waste Potential

This table identifies all of the dairymen of the Enumclaw and assesses their likelihood for participating in a digester project. Each is assigned a grid location from the aerial map matching with roads and streets. For those identified as "probable" participants in a digester project, transportation costs are estimated from their farms to a central point using the costs per ton-mile from Exhibit 3. Those estimated costs are totaled for all probable participants.

From Step 1-Task 1.

Exhibit 3 – Waste Transport Cost Calculation

Calculation methodology for truck transport of material to a central site. Key points are miles driven, driver hours, truck operating costs and driver pay.

From Step 1- Task 4.

Exhibit 4 – Collective Transport Cost to Various Grid Locations

Using the calculation format of Exhibit 2, transport costs are calculated for each point in the total grid. A "bullseye" pattern develops showing minimum transport cost locations for a central site.

From Step 1- Tasks 1 and 4.

Exhibit 5 – Regional Nutrient Management Estimate – Current

The nutrient management plan of one of the larger dairies is used to evaluate the cropland requirements for the "agronomic use" of nutrients from animal wastes. Key point – for the approximate total number of cows on the Enumclaw plateau, over 8,000 acres of cropland is needed for application as long as Nitrogen is the limiting nutrient. But over 13,000 will be needed when P2O5 becomes the limiting nutrient. Column codes represent a crop and yield combination – 6T GS is 6 ton per acre grass silage.

From Step 1- Tasks 1 and 4.

Exhibit 6 -- Regional Nutrient Management Estimate -- With Digester

The same methodology as for Exhibit 5, but for "improved" nutrient management resulting from a much higher removal of solids (which are exported) and the return of only 2/3 of the residual nutrient-rich water to the dairies. Key point – land base required for the existing cow herd is reduced by over half, significantly reducing the "difficulty" of utilizing the nutrients from the existing cow herd or allowing more cows to be added to the milking herd.

From Step 1- Tasks 1 and 4.

Exhibit 6a – Graphic Comparison of Nutrient Management Options

This chart summarized the information from the previous two tables. Notice, particularly, how much better balance there is between the nitrogen and phosphorus in the "improved" option.

From Step 1- Tasks 1 and 4.

Exhibit 7 – Various Capital Costs and Income Assumptions

Numbers in the left column are mostly calculated within the computer model. Those in the right column are inputs based on known factors or key assumptions for the economic feasibility of the project.

Includes elements from Step 1-Tasks 1, 2, 3 and 4.

Exhibit 8 – Estimating Carbon Credit Potential

Methodology for "superficially" estimating the potential carbon credits for the project. This calculation does not include N2O credits and is intentionally conservative in its calculation. Actual credits must be determined with a certified audit.
Includes elements from Step 1-Tasks 2, 3 and 4.

Exhibit 9 – Estimated Costs for Concrete and Tanks

These cost estimates use concrete costs from the local supplier and tank costs from the manufacturer of "glass fused to steel" pre-engineered tanks.

From Step 1- Task 4

Exhibit 10 – One Potential Site Layout

This site drawing is for "visualization" of required acreages, truck movements, expansion room and water storage. Though cropped in the picture, the pond shown is square and the site occupies 15 acres. Minimum space could be as little as half that shown, but leaving little space for expansion or associated business activities.

Includes elements from Step 1-Tasks 1, 2, 3 and 4.

I. Enumclaw Plateau Dairymen

1. Total dairies on plateau – 30 Number of milking cows – near 9000
2. Likely to participate in a digester project – at least 15 dairies and 6000 cows
3. Waste is handled by daily scraping with minimal water added. Parlor wash water and rainfall are dilutants.
    a. Underground storage tanks
    b. Some have solids separators, others need them
    c. Pump to storage ponds
    d. Irrigate to land as possible
    e. Many transport to surrounding property, owned, leased or "give away" nutrients
4. Bedded with sawdust or shavings – estimate 3 lbs per head per day annual average
    a. No bedding with composted solids
5. Odor and associated neighbor problems were not a major issue with most, but is always a "concern".
6. Separated solids are given away, mostly to Carpinito Bros who haul them to Kent for "composting" and sale.
7. Most are third generation dairymen and well "rooted" in the area.
8. Mostly high production herds – primarily Holsteins and at least one Jersey.
9. All are currently operating "in the red" as milk is at a 20 year low, with no end in sight. Milk prices are cyclical and this is a very low cycle.
10. Most would milk more cows if they could.
    a. To stay competitive – must increase scale as in all of agriculture
    b. Waste management is primary restricting factor (other than milk prices)
    c. Waste (nutrients) management is time consuming and costly, with most of the readily available land currently being utilized
11. All are operating under "nutrient management plans" which control how and where they apply nutrients.
12. Nitrogen is limiting nutrient for plans, even though the new CAFO regulations specify "first limiting nutrient" which would be phosphorus. A phosphorus limitation would likely double the required application land and would be devastating for these dairymen.
13. The nitrogen limitation is "grandfathered" into their nutrient management plans, but they would lose the "grandfather" if animal numbers increase more than 10%.
14. **MANAGEMENT OF WASTES IS SEVERELY RESTRICTING THESE DAIRYMEN and** will continue to do so in the future.
15. Electric bills average $2.50-3.00 per cow per month, and the average KWH rate is 6-7 cents.
16. They have no money to invest in a digester – individual or centralized – due to low milk prices.
17. They cannot participate in a digester project if it "costs" them money – net of identified savings
18. Savings include
    a. Waste transport costs
    b. Solids separation
    c. Pumping and agitation costs
    d. Hired and personal labor
    e. Other equipment costs
19. Value of a central digester includes
    a. Nutrient management (disposal)
    b. Savings of power (electric) costs
    c. Mortality disposal
    d. Allow to expand
20. Preferred ownership of a central facility
    a. Not a cooperative
    b. Perhaps the state or county
    c. Utility company or independent company
    d. Combination ownership including dairymen
21. Land with development rights will cost $10-15,000 per acre.

Conclusions:

1. Dairymen would use a central digester if it is affordable.
2. 15-20 dairies, 6,000 to 8,000 cows likely participation
3. Waste handling methods allow economical transport if "added" water is controlled.

4. Nutrient management is MAJOR restricting factor for current operations
5. Without nutrient restrictions, most producers would increase herds in effort to stay competitive.
6. They have no money to invest in such a facility at this time – low milk prices.
7. Added benefits – lower electric costs and mortality disposal.

II. Non-Dairyman Information Collection

Puget Sound Energy

1. Purchase power -- $30-40 per MWH
2. Plus BPA's "Conservation Renewable Reserve" of $10 per MWH
3. Interconnect cost of $300-500,000 for a 1+ MW generator, or about $250 per KW.
4. Underground line cost of $200-300,000 per mile.
5. Interested in purchase of "green tags" through BEF.
6. Existing power line capabilities – see map. Good fit.
7. Might build, own, maintain and lease to the project the generators and interconnects.
8. Financial support of the project -- ?????

Seattle City Light

1. Primarily interested in "carbon credits"
2. Would purchase the power but probably not best candidate
3. Value of CO2e -- $4 or so per tonne, perhaps more with "other considerations"
4. Want to support the project, to be recognized as a significant contributor
5. Financial support of the project -- ?????
6. Prospective "size" of the project is larger than expected

Bonneville Environmental Foundation

1. Interested in acquiring the "renewable attributes" for resale as "green tags"
2. Might be able to steer some "grant money" to the project
3. Current "oversupply" makes them worth only perhaps one half cent.

King County Solid Waste

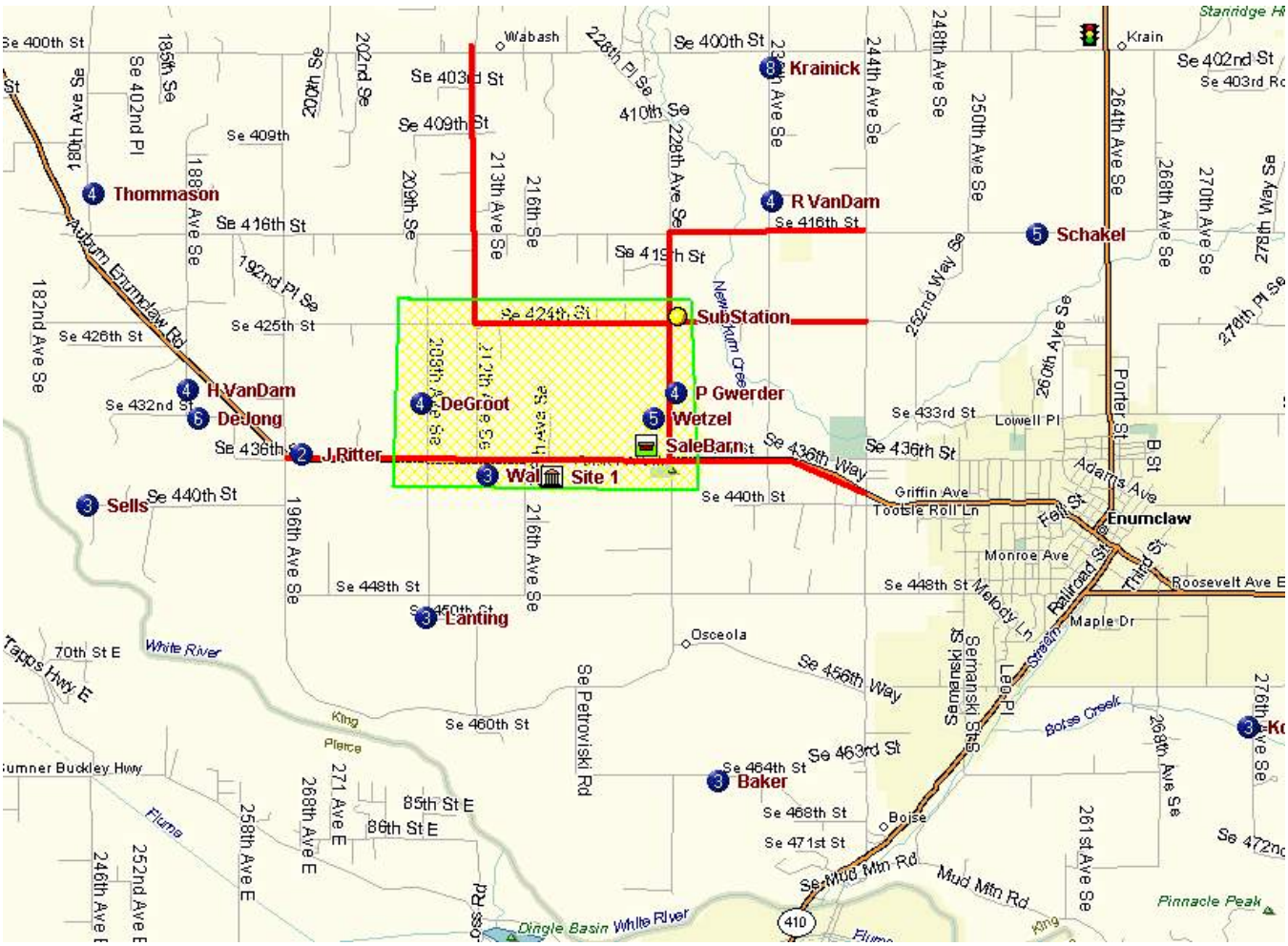
1. Other potential digestible waste streams
2. Horse Manure
3. City of Enumclaw food and yard waste
    a. 4,000 to 5,000 tons per year
    b. City collection system
    c. Tipping fee at county landfill -- $82 per ton
    d. Visited with City on the subject
4. Cedar Grove Composting – private company
    a. 150,000 yards per year of compost

King Conservation District

1. Farm visits with dairymen – Clare Flanagan is invaluable resource.
2. Nutrient management information

3. Facility cost information
4. Land use
5. Ross Lahren – state director of EQIP Program
    a. Standards are being developed for digesters
    b. Centralized projects should be okay
    c. 3 county funding prospect – total of $1.8 to 2 million per year for all projects.
    d. May have difficulty finding enough projects to allocated the mandated 60% to animal projects.

Exhibit 1 -- Map Showing Prime Location for Central Digester



1. Red lines are power lines easily capable of handling 1 MW power generation load.
2. Yellow area is prime location area from the standpoint of inbound transportation.
3. Site 1 is an excavating company yard and is probably available to purchase. Another available site is directly across the road to the north.
4. Blue dots are "likely participant" dairies

Exhibit 2 – Dairies of Enumclaw Plateau and Waste Potential

Dairies of the Enumclaw Plateau and Transport Costs to a Central Site

		Likelihood for Participation				Grid location		Transport cost Calculation				
					Not	x	y	Haul				
Dairy	Address	Prob	Likely	Maybe	Likely	3.5	2.25	Miles	Gal/day	Ton-miles/yr	$/yr	$/cow
		------Milking Herd------										
1		**300**				3.75	0.5	2	9000	27,266	$8,180	$27.27
2					110							
3		**400**				2.75	1.5	1.5	12000	27,266	$8,180	$20.45
4		**600**				1.5	2.5	2.25	18000	61,347	$18,404	$30.67
5		**400**				4	2.5	0.75	12000	18,177	$5,453	$13.63
6					**400**							
7			**200**									
8		**300**				7	0.75	5	9000	68,164	$20,449	$68.16
9		**800**				4.5	4.5	3.25	24000	118,151	$35,445	$44.31
10					130							
11		**275**				2	1.75	2	8250	24,993	$7,498	$27.27
12					80							
13					40							
14		**200**				2.25	2.25	1.25	6000	11,361	$3,408	$17.04
15		**500**				5.75	3.5	3.5	15000	79,524	$23,857	$47.71
16					130							
17		**300**				1.75	2	2	9000	27,266	$8,180	$27.27
18				70								
19					**250**							
20				**260**								
21					130							
22		400				1	4	4.25	12000	77,252	$23,176	$57.94
23				**400**								
24		**400**				1.75	2.75	2.25	12000	40,898	$12,269	$30.67
25		**400**				4.5	3.75	2.5	12000	45,443	$13,633	$34.08
26					100							
27				**300**								
28					300							
29		**300**				3	2.25	0.5	9000	6,816	$2,045	$6.82
30		**500**				4	2.75	1	15000	22,721	$6,816	$13.63
	Cows	6075	200	1030	1670			34	182,250	656,644	$196,993	$32.43
							Ave Miles	2.27				
							Tons/Yr	276,063				
							Per Ton-Mile	**$0.30**				

1. Likelihood for participation in a digester project based on personal interviews and assessment of conservation district personnel.

2. Grid location based on aerial map. Location of a potential central site determines haul miles and costing.

3. Assumes 30 gallons of total waste per cow per day.

This table identifies all of the dairymen of the Enumclaw and assesses their likelihood for participating in a digester project. Each is assigned a grid location from the aerial map matching with roads and streets. For those identified as "probable" participants in a digester project, transportation costs are estimated from their farms to a central point using the costs per ton-mile from Exhibit 3. Those estimated costs are totaled for all probable participants.

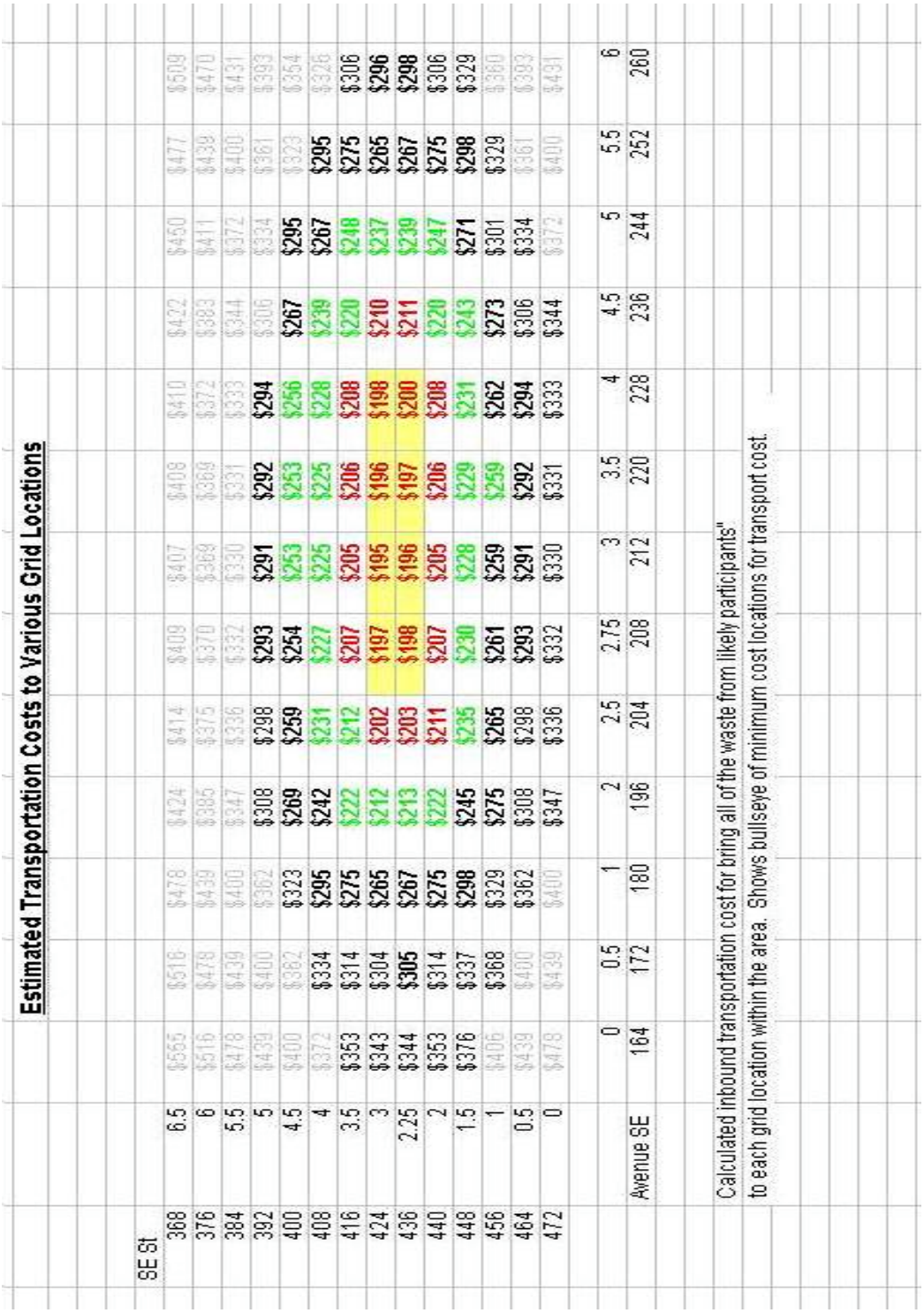
Exhibit 3 – Waste Transport Cost Calculation

King County Transport Costs

No. Locations	**15**
Ave Haul miles (one way)	**2.30**
Total daily gallons	**182,250**
Ave Load gallons	**5,500**
Lbs/Gal	**8.3**
Avg Load tons	22.825
Ave Cows	**405**
Ave Waste Gal/cow/day	**30**
Ave Road speed	**15**
Turnaround (minutes/trip)	**30**
Ave Min/Trip	48.40
Ave trips/day	33.14
Ave miles/day	152.43
Annual trips	12,095
Daily trips@ 6 days/wk	31.27
Annual miles	55,636
Annual Hours	9,756
Annual Tons	276,063
Driver Hourly	**$15.00**
Tractor $/Mi	**$0.75**
Annual Driver	$146,347
Annual Tractor	$41,727
Total	$188,074
Per mile	$3.38
Per 1000 Gal	$2.83
Per Cow	$30.96
Per Trip	$15.55
Per Ton	$0.68
Per ton-mile (one way)	$0.296

Calculation methodology for truck transport of material to a central site. Key points are miles driven, driver hours, truck operating costs and driver pay.

Exhibit 4 – Collective Transport Cost to Various Grid Locations



Estimated Transportation Costs to Various Grid Locations

SE St															
368	6.5	$565	$516	$478	$424	$414	$409	$407	$408	$410	$422	$450	$477	$509	
376	6	$516	$478	$439	$385	$375	$370	$369	$369	$372	$383	$411	$439	$470	
384	5.5	$478	$439	$400	$347	$336	$332	$330	$331	$333	$344	$372	$400	$431	
392	5	$439	$400	$362	$308	$298	**$293**	**$291**	**$292**	**$294**	$306	$334	$361	$393	
400	4.5	$400	$362	$323	**$269**	**$259**	**$254**	$253	$253	**$256**	**$267**	**$295**	$323	$354	
408	4	$372	$334	**$295**	**$242**	$231	$227	$225	$225	$228	$239	**$267**	**$295**	$326	
416	3.5	$353	$314	**$275**	$222	$212	$207	$205	$206	**$208**	$220	$248	**$275**	**$306**	
424	3	$343	$304	$265	$212	$202	$197	$195	$196	$198	$210	$237	$265	**$296**	
436	2.25	$344	**$305**	$267	$213	$203	$198	$196	$197	$200	$211	$239	$267	**$298**	
440	2	$353	$314	$275	$222	$211	$207	$205	$206	$208	$220	$247	$275	$306	
448	1.5	$376	$337	$298	$245	$235	$230	$228	$229	$231	$243	$271	$298	$329	
456	1	$406	$368	$329	$275	$265	$261	$259	$259	$262	$273	$301	$329	$360	
464	0.5	$439	$400	$362	$308	$298	$293	$291	$292	$294	$306	$334	$361	$393	
472	0	$478	$439	$400	$347	$336	$332	$330	$331	$333	$344	$372	$400	$431	
		0	0.5	1	2	2.5	2.75	3	3.5	4	4.5	5	5.5	6	
Avenue SE		164	172	180	196	204	208	212	220	228	236	244	252	260	

Calculated inbound transportation cost for bring all of the waste from likely participants"
to each grid location within the area. Shows bullseye of minimum cost locations for transport cost.

Using the calculation format of Exhibit 2, transport costs are calculated for each point in the total grid. A "bullseye" pattern develops showing minimum transport cost locations for a central site.

Exhibit 5 – Regional Nutrient Management Estimate – Current

Comprehensive Nutrient Management Planning

Total Cows	6,075	Suspended Solids Recovery	**45%**
Discharge water	55,852,568	Return to Farm	**100%**
000 gal/cow	9.19	N Lost in Handling	**40%**

N	/cow	103.40	N	/000gal	11.25
P2O5	/cow	51.59	P2O5	/000gal	5.61
K2O	/cow	113.12	K2O	/000gal	12.30

	Crops					
	6T GS	5T GS	3.5T GS	3T H/P	2.5T P	Mix
Crop Agronomic Use	19%	33%	20%	14%	14%	100%
N	**300**	**250**	**175**	**198**	**165**	225
P2O5	**55**	**46**	**32**	**27.5**	**23**	39
K2O	**144**	**120**	**84**	**122**	**102**	115
Organic Matter N	**120**	**100**	**100**	**90**	**80**	100
Allowed App N	180	150	75	108	85	126
000 Gal/Acre						
N Limiting	16.00	13.34	6.67	9.60	7.56	11.18
P2O5 Limiting	9.80	8.20	5.70	4.90	4.10	6.97
Acres per Cow						
N Limiting	0.57	0.69	1.38	0.96	1.22	0.82
P2O5 Limiting	0.94	1.12	1.61	1.88	2.24	1.32
Acres per 100 Cows						
N Limiting	57	69	138	96	122	82
P2O5 Limiting	94	112	161	188	224	132
Acres per 10000 Cows						
N Limiting	5,744	6,893	13,787	9,574	12,165	8,225
P2O5 Limiting	9,379	11,215	16,121	18,759	22,429	13,194

The nutrient management plan of one of the larger dairies is used to evaluate the cropland requirements for the "agronomic use" of nutrients from animal wastes. Key point – for the approximate total number of cows on the Enumclaw plateau, over 8,000 acres of cropland is needed for application as long as Nitrogen is the limiting nutrient. But over 13,000 will be needed when P2O5 becomes the limiting nutrient. Column codes represent a crop and yield combination – 6T GS is 6 ton per acre grass silage.

Exhibit 6 -- Regional Nutrient Management Estimate -- With Digester

Comprehensive Nutrient Management Planning

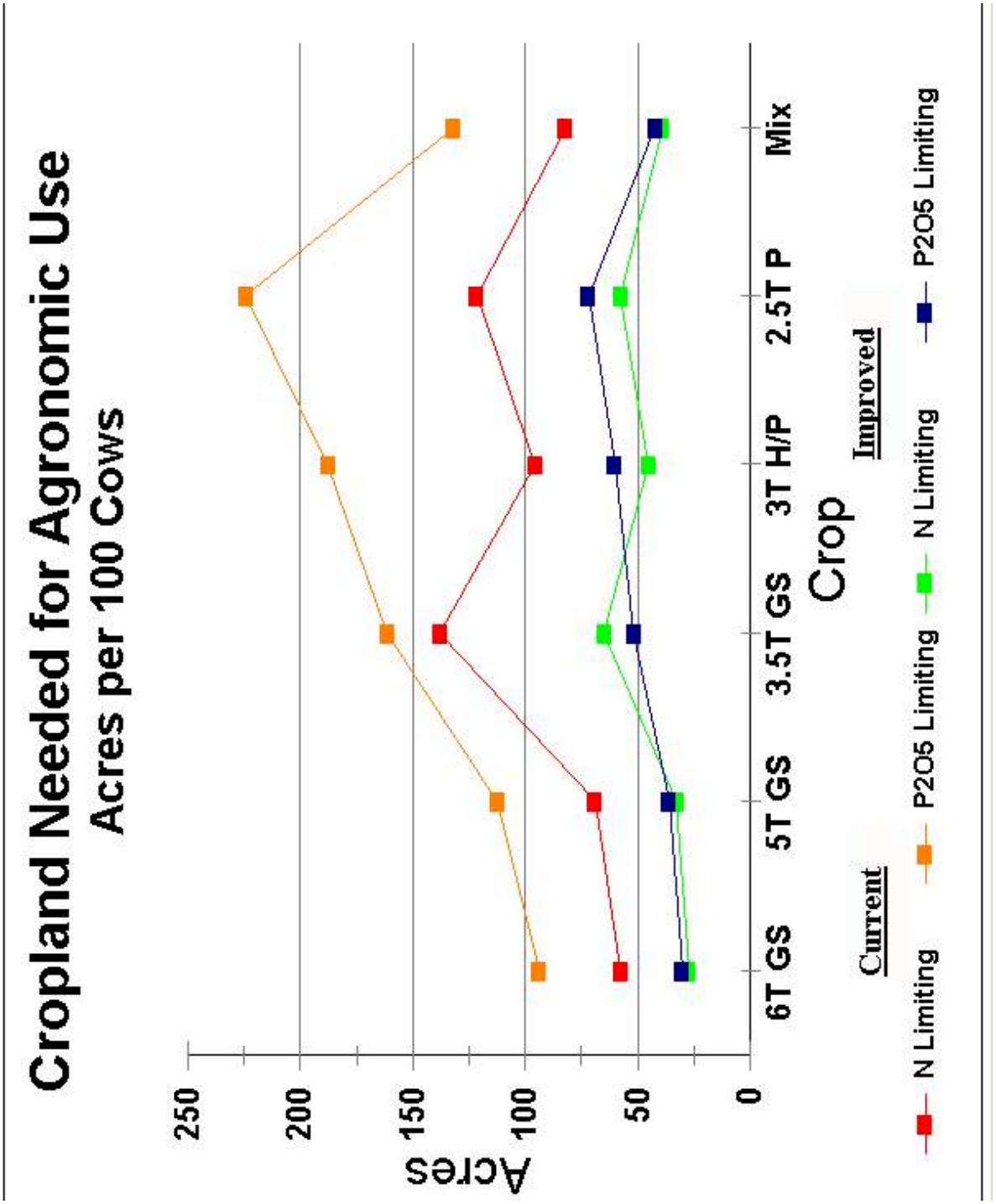
Total Cows	6,075	Suspended Solids Recovery	**85%**	
Discharge water	53,176,717	Return to Farm	**67%**	
000 gal/cow	8.75	N Lost in Handling	**40%**	

N	/cow	48.69	N	/000gal	8.30
P2O5	/cow	16.50	P2O5	/000gal	2.81
K2O	/cow	48.21	K2O	/000gal	8.22

	Crops					
	6T GS	5T GS	3.5T GS	3T H/P	2.5T P	Mix
Crop Agronomic Use	19%	33%	20%	14%	14%	100%
N	**300**	**250**	**175**	**198**	**165**	225
P2O5	**55**	**46**	**32**	**27.5**	**23**	39
K2O	**144**	**120**	**84**	**122**	**102**	115
Organic Matter N	**120**	**100**	**100**	**90**	**80**	100
Allowed App N	180	150	75	108	85	126
000 Gal/Acre						
N Limiting	21.68	18.07	9.03	13.01	10.24	15.14
P2O5 Limiting	19.55	16.35	11.37	9.77	8.17	13.90
Acres per Cow						
N Limiting	0.27	0.32	0.65	0.45	0.57	0.39
P2O5 Limiting	0.30	0.36	0.52	0.60	0.72	0.42
Acres per 100 Cows						
N Limiting	27	32	65	45	57	39
P2O5 Limiting	30	36	52	60	72	42
Acres per 10000 Cows						
N Limiting	2,705	3,246	6,492	4,508	5,728	3,873
P2O5 Limiting	3,000	3,587	5,157	6,001	7,175	4,220

The same methodology as for Exhibit 5, but for "improved" nutrient management resulting from a much higher removal of solids (which are exported) and the return of only 2/3 of the residual nutrient-rich water to the dairies. Key point – land base required for the existing cow herd is reduced by over half, significantly reducing the "difficulty" of utilizing the nutrients from the existing cow herd or allowing more cows to be added to the milking herd.

Exhibit 6a – Graphic Comparison of Nutrient Management Options



This chart summarized the information from the previous two tables. Notice, particularly, how much better balance there is between the nitrogen and phosphorus in the "improved" option.

Exhibit 7 – Various Capital Costs and Income Assumptions

Capital Cost

Transport Trailers	18			$15,000
Transport Tractors	12			$15,000
Fertilizer Plant Fixed	1			$500,000
Fertilizer Plant Variable	25,779	Tons	@	$20
PSE Interconnect & Lines	1			$450,000
Reserved for Collective Capital	1			
				Total

Income

Processing Fee	6,075	Milkers	@	$32.50
Organic Residuals Sale	25,779	Tons	@	$20.00
Renewable Energy PTC	10,770,658	KWHr	@	$0.018
Carbon Credits	32,004	M Tons	@	$5.00
Ren. Energy Credit (Green tags)	10,770,658	KWHr	@	$0.010
Nutrient Rich Water	18,172	000 G	@	$5.00
				Total

Operating Cost

Residuals Handling (not bagging)	25,779	Tons	@	$5.00
Facility Operation exc GenSet	1			$300,000
Transport Cost	265,097	Tons	@	$0.75

Numbers in the left column are mostly calculated within the computer model. Those in the right column are inputs based on known factors or key assumptions for the economic feasibility of the project.

Exhibit 8 – Estimating Carbon Credit Potential

Estimating Baseline Methane Emissions for the King County Project

6,000	Head		Handling	Methane	
1,400	Ave Live Wt	Method	Pct	of Pot	
8,400,000	Live Lbs				
3.65	Annual VS lbs/lb bod wt	An Lagoon	50.00%	90.00%	45.00%
30,660,000	Annual lbs VS	Liq Slurry	50.00%	15.50%	7.75%
3.84	FT3 CH4/lb VS	Daily Spread	0.00%	0.20%	0.00%
117,734,400	Total CH4 Potential (FT3)	Total			52.75%
52.75%	Handling Factor for Enumclaw Plateau				
62,104,896	FT3 CH4/lb VS				
42.28	lbs/1000 CH4				
2,625,795	lbs CH4				
1,191	MT CH4				
22	GHG equivalency				
26,198	MT CO2e				

Methodology for "superficially" estimating the potential carbon credits for the project. This calculation does not include N2O credits and is intentionally conservative in its calculation. Actual credits must be determined with a certified audit.

Exhibit 9 – Estimated Costs for Concrete and Tanks

Facility costing

Plug Flow Concrete

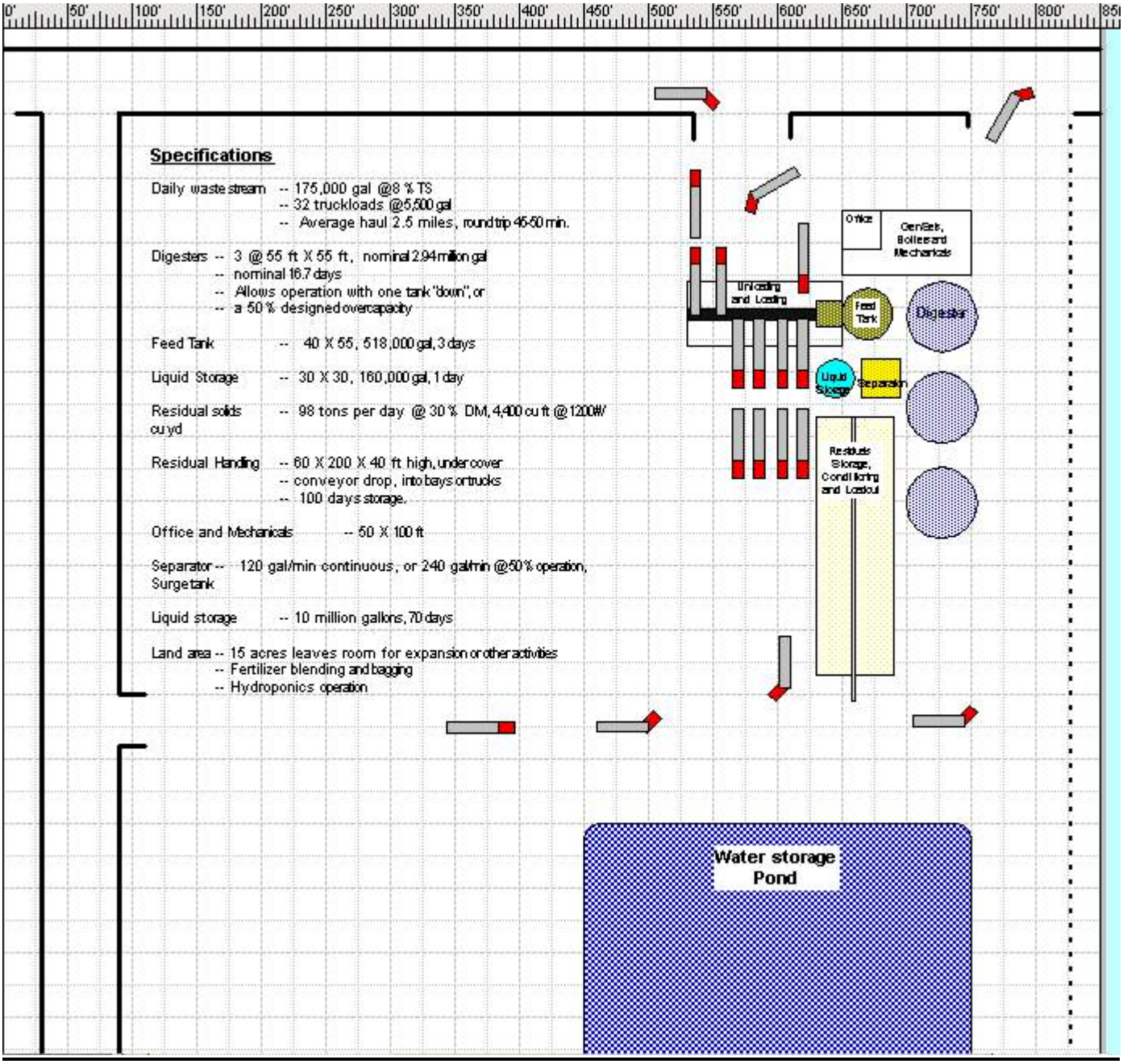
175,000	gal/day		$67.00	concrete
30	days		4	fabrication
5,250,000	gal			
700,000	ft#			
3	units			
233,333	ft3/unit			
15	depth			
20	width			
778	length			
Ft2		Thick		Yards
15,556	floor	12		576
808	walls	12		30
600	ends	12		22
15,556	top	6		288
				916
				2,749
				$736,735

Mixed tanks

Thermo			Meso	
175,000	gal/day		175,000	gal/day
15	days		30	days
2,625,000	gal		5,250,000	gal
3	units		6	units
875,000			875,000	
$0.35			$0.35	
$918,750			$1,837,500	

These cost estimates use concrete costs from the local supplier and tank costs from the manufacturer of "glass fused to steel" pre-engineered tanks.

Exhibit 10 – One Potential Site Layout



This site drawing is for "visualization" of required acreages, truck movements, expansion room and water storage. Though cropped in the picture, the pond shown is square and the site occupies 15 acres. Minimum space could be as little as half that shown, but leaving little space for expansion or associated business activities.